3D Photovoltaics Group

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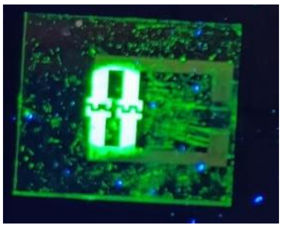
Research Theme: The goal of the group 3D Photovoltaics is to push the frontiers of nano-PV by aiming towards the achievement of low-cost semiconductor nanostructures as building blocks. We focus on the fundamental understanding of the potential benefits and/or limitations of semiconductor nanostructures when used for solar energy conversion. These include exploring non-traditional conversion principles enabled by the nano geometry or the development of cost-effective nanofabrication methods.

1. **New route for perovskite nanopatterning**

Supervisors: Daphne Antony and Esther Alarcon Llado

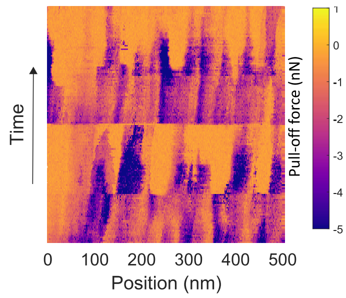
Organic-inorganic perovskite nanostructures are very promising for optoelectronic applications. However, perovskite nano-structuring is very challenging as conventional lithography methods often involve processing steps that damage the perovskite material. In this project, we will develop the bottom-up of growth of perovskite nanostructures by using selective electrochemical deposition. We will explore the limitations of this method in terms of material quality and patterning resolution.



2. **Atomic force probe investigation of electrode-electrolyte interfaces**

Supervisors: Daphne Antony and Esther Alarcon Llado

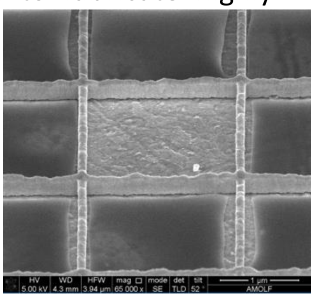
Electrification will only occur once we find efficient, stable and earth abundant electrocatalysts. On this quest, a key information is missing: the structure of solid-liquid interfaces. In this project we will use state-of-the-art electrochemical nanometric probes in the desired electrolyte for CO_2 reduction. We will then use the adhesion measurements to correlate the catalytic activity on the same surface. These nanoscale observations on spatial inhomogeneities will be important step towards better catalyst design and application.



3. **Towards roll-to-roll fabrication of metal nanowires networks**

Supervisors: Yorick Bleiji and Esther Alarcon Llado

Metal nanowire networks (MNNs) are new class of transparent conductive electrodes that will boost PV performance. We have recently developed a method to fabricate highly performing MNNs with selective area electrodeposition, which requires a lithography step. In this work, we will explore the direct patterning by spatially confining the electrolyte using a nanopatterned PMDS stamp, a new single step method compatible with roll-to-roll production. In this project you will learn the fundamentals of electrochemistry and nanophotonics, analyze samples using a various amount of characterization techniques (including electron microscopy, atomic force microscopy and optical spectroscopy), and contribute to the development of a new technique.



4. Hyperuniform Light Trapping Via Large-Area Self-Assembly

Supervisors: Alex Lambertz and Esther Alarcon Llado

Do you like to work with your hands and can identify and tackle problems autonomously? Are you interested in solar cells and want to help the next generation of highly-efficient ultra-thin PV to market? Then this might be for you! Hyperuniform nanopatterns are exceptional light trappers in thin films as they remedy the shortcomings of periodic and random texturing approaches. You will establish hyperuniform self-organizing on very large scales and combine it with nanofabrication techniques as well as acquire expertise in optical and electrical characterization of solar cells. You will explore different deposition routes and try to gain control on the nanometer scale by adjusting macroscopic process parameters.